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VentureStar Operations Options
at Cape Canaveral Air Station and
the Kennedy Space Center
By Robert Wayne Eleazer, III

Purpose

The purpose of this paper is to identify and analyze possible approaches to supporting the Lockheed Martin VentureStar vehicle at Cape Canaveral Air Station (CCAS) and the Kennedy Space Center.

Vehicle Description, Background, and Assumptions

The VentureStar is a large Reusable Launch Vehicle (RLV) being designed and built by an industry team led by Lockheed Martin. The X-33 is the experimental sub scale predecessor to the VentureStar and is being funded in part by NASA. The VentureStar is envisioned as a fully reusable launch system capable of repeated flights with minimal refurbishment. The RLV will be operated commercially and carry civil, military, and commercial payloads into orbit, including support of the International Space Station.

Lockheed Martin is studying possible launch sites for the VentureStar, and 18 states are known to have submitted site qualification summaries. It is presumed at this time that Lockheed Martin will require leasing, teaming, or other arrangements so to minimize the company's investment in launch site infrastructure.

In this paper we have made the following assumptions:

1. VentureStar processing methods can be modified from the baseline approach defined by LMA in order to take advantage of available resources.
2. LMA will require two VentureStar launch pads and capabilities to process two vehicles, but the second pad and support facilities will not be built until some time after the first.
3. First launch of the VentureStar will be NET late CY 2004.
4. A runway a minimum of 10,000 ft long and at least 300 ft wide be suitable for landing of the VentureStar. Assuming load bearing capabilities are adequate, the runway material may be either asphalt or concrete.
5. Range/flight safety concerns will be addressed by using modified traditional methods (Reference 36th Space Congress paper “Launch Safety Principles for RLVs”).
6. Once the VentureStar has assumed all or a large portion of the Space Shuttle mission set, LC-39A or B will become available for other programs.
7. The last Titan IV will fly from SLC-40 at CCAS in 2002.

Baseline Operations Approach

In the baseline VentureStar operations approach, the vehicle is processed horizontally in a suitable facility essentially on the launch pad. The payloads are installed in the processing facility. Within a few hours of launch the processing facility is removed from the site, the vehicle is erected vertically at the launch pad, fueling of liquid Hydrogen and liquid Oxygen is conducted, and the vehicle is launched.

Following a mission length of from a few hours to a few days, the vehicle lands horizontally on a suitable runway, preferably in relatively close proximity to the launch

pad and processing facility. The vehicle is then either towed on its own gear or on a transporter to the processing facility/launch pad and processed for another mission.

For the initial VentureStar operations it is possible that in addition to a processing facility, a manufacturing facility will be utilized to accomplish final assembly of the vehicle. This facility may or may not be one in the same with the launch processing facility. It is probable that the construction facility will be separate from the processing facility and launch pad in order to facilitate construction of additional vehicles.

Option 1: SLC-48 with a new processing facility, the CCAS Skid Strip, and a new assembly facility

A potential VentureStar launch site designated SLC-48 has been identified Southeast of the Eastern end of the CCAS Skid Strip, East of Pier Road. The SLC-48 launch pad location can meet the basic requirements of VentureStar in that a 3500 ft explosive safety area (Quantity Distance area or QD) can be established without impacting other operations. The current CCAS site used for explosives destruction is just South of the site and would have to be relocated, but this should cause no real difficulty.

At the SLC-48 site, a processing facility would be built on top of the launch pad and the building rolled back for erection of the vehicle, fueling, and launch. The vehicle would be processed horizontally, essentially as in the Baseline Approach. Landing would be on the Skid Strip, any defueling operations would be located off of the Skid Strip, probably on the taxiway leading to the pad. A new taxiway of approximately 3600 in length would be required, and in order to facilitate defueling should be constructed of concrete with LOX compatible expansion seals. The new taxiway probably would cross the LC-32 and LC 33 sites, would should present no problems. The taxiway also would cross Pier road, but could do so with only the addition of electrically controlled warning lights and gates similar to those used for a railroad crossing. Should it be desired to extend the Skid Strip to 15,000 ft in length the land in the area would easily enable such construction, and the crossing gates and warning light technique would also enable Pier Road to continue to be used.

The SLC-48 site is undeveloped but has ready access to the Skid Strip and to existing electrical power, water, communications, and could be connected to the existing Gaseous Nitrogen pipeline at SLC-36 with an extension of 7000 ft.

For assembly of the VentureStar vehicles, it would be preferable to construct a new facility either at the Northwestern end of the Skid Strip or near where Control Tower Road intersects the runway. Placing such an assembly facility adjacent to the Skid Strip parking apron would be undesirable due to the planned use of the East side of the apron for parking the L-1011/Pegasus.

The SLC-48 site would require new construction but much of it would be on previously disturbed land, thereby reducing adverse environmental impact. In fact, there is now a road at the site and a small area of contaminated soil.

Due to the location of the SLC-48 site, it is unlikely that any instrumentation line-of-site problems would occur. The assembly facility sites would have to evaluated in terms of line of sight problems.

The SLC-48 site would be impacted by and would impact ELV operations from SLC-36A, SLC-36B, SLC-46, SLC-17A, and SLC-17B. Evacuation of SLC-48 would be required for launches from any of these sites and RLV operations at SLC-48 would likely impose evacuations at least at SLC-36 and SLC-46. The only impact would be on launch day, and test operations requiring fueling would probably only require road closures but not evacuations.

The addition of another VentureStar pad in the vicinity of SLC-48 would not be particularly easy due to the proximity of other launch facilities. Therefore we have developed Option 1B.

Option 1A: Option 1 plus use of LC-39 A or B for the second pad, and the KSC Shuttle Landing Facility

This option is similar to Option 1, but assumes that a second pad for VentureStar will not be required until the pad has become fully operational and therefore has assumed most or all of the Space Shuttle mission set.

One of the Space Shuttle pads, LC-39A or LC-39B would be made available for use by VentureStar. A processing facility would be constructed on or adjacent to the chosen pad. Modifications would be required to enable VentureStar access to the rail line to the East of the chosen pad. The same type of rail transporter would be used as described with Option 3, and the vehicle would land on the SLF, be mated to the rail transporter, be raised to the vertical position, and be taken to the pad for processing. Alternatively a suitable taxiway and ground transporter vehicle could be constructed if the rail transporter concept was not to be used.

Option 1B offers the advantage of reduced infrastructure investment to attain a second pad and enables the two pads to be well separated and therefore cause a minimum of interference. It makes little use of undisturbed land, so environmental impact should be minimal. However, there would be some impact by and to Space Shuttle operations on the other LC-39 pad; the flexibility afforded the VentureStar program by the use of two such widely separated pads should help to reduce such impacts.

Option 2: New KSC site with a new processing facility, the KSC Shuttle Landing Facility, and a new assembly facility

Option 2 involves the construction of a new VentureStar pad in a currently largely undisturbed area to the North of the LC-39 complex. The VentureStar pad would make use of the baseline approach. The SLF would be used for landing and a suitable taxiway and potentially a ground transporter vehicle would be constructed to support the 5 mile transport from the runway to the pad. Initial assembly of the vehicle could be made at the processing facility or at a new assembly facility near the SLF. A new launch control complex would be built at a suitable location or an existing facility modified. Essentially, the Baseline Approach would be used.

Option 2 would require a relatively large amount of construction, including considerable filling of swampy ground. Both infrastructure investment costs and environmental impact would be the greatest of any of the options, but would be comparatively small in comparison to the effort required to construct the Saturn 5 and Space Shuttle pads.

Line of Sight problems are likely to be minimal for Option 2, but care would have to be taken in the location of the assembly facility.

The new VentureStar pad to some degree would be impacted by and would impact operations at LC-39. The primary impact would be on launch day. Impact to other KSC operations would be minimal.

Option 2A: Option 2 plus use of LC-39 A or B for the second pad

The desire to locate a second VentureStar pad on KSC has given rise to Option 2A, which involves the use of LC-39A or B after most or all of NASA's Space Shuttle class cargo needs have been met by VentureStar. This approach would be basically the same as Option 1A, except that instead of a rail transporter a suitable taxiway might be constructed from the SLF to LC-39 and/or a ground transport vehicle developed.

Option 3: The Titan IV SMARF, SLC-40, and the KSC Shuttle Landing Facility

The previous options have all assumed adherence to the baseline approach of horizontal transport of the VentureStar. This option proposes a different approach to take advantage of existing high-value infrastructure

Initial assembly and recurring processing of the VentureStar would take place in the Solid Motor Assembly and Readiness Facility (SMARF). The SMARF is currently used for assembly of Titan IV solid rocket booster stages and mating of the stages to the core vehicle. The last Titan IV use of the SMARF and SLC-40 is planned for 2002 and the facilities could be made available for VentureStar use in 2003.

The SMARF is in many ways well suited for both assembly of and processing of the VentureStar vehicle. The facility has both a 500 ton and a 100 ton ordnance-rated crane, is fully enclosed, and is ordnance sited far above that required for VentureStar assembly and pre-launch processing operations. Handling of fueled spacecraft with on-board solid rocket motors should not present a problem in the facility. Should major subassemblies of the VentureStar be transported by water, the SMARF has nearby access to the Banana River and a temporary wharf can be constructed adjacent to the facility with little difficulty and minimal environmental impact.

The SMARF is capable of handling the VentureStar vertically without modification. Even with the complete vehicle in a vertical position, a crane hook clearance in the vicinity of 40 ft would be available. In order to enable the VentureStar to be assembled or processed horizontally some structural modification of the interior of the facility would be required. In any case, the door size of the facility would necessitate raising the vehicle to the vertical or launch position to enter or leave the facility. However, the rail access to the SMARF enables us to take advantage of this requirement

Loading of payloads into the VentureStar could be accomplished in the SMARF with little difficulty and under "all weather" conditions. The facility has an explosives safety ordnance rating far in excess of any conceivable payload requirement. Should propellant loading of payloads be required in the SMARF, some facility modifications might be necessary, but it is not likely that payload propellant loading would be required.

Once the VentureStar is ready to go to the launch pad, the cranes in the SMARF would be used to raise the vehicle to the vertical launch position (if required) and place it on a special rail transporter vehicle. It may be possible to convert surplus Titan IV transporters for VentureStar use. A number are available.

The vehicle on its rail transporter would leave the SMARF through the main door on the South side of the building and proceed to SLC-40 for fueling and launch. The SLC-40 Umbilical Service Tower would be removed and the pad's Mobile Service Tower (MST) would be either demolished or parked in the aft position. The existing flame bucket at SLC-40 would be modified as required. The rail transporter would likely be removed after the vehicle was in position at the pad.

The rail access to SLC-40 might be used to facilitate transportation of the hydrogen and oxygen propellants from the manufacturing facility. This would reduce the need for propellant storage tanks on the site, eliminate the need for numerous over-the road tanker truck trips, and facilitate non-VentureStar use of the propellant production facility.

After launch from SLC-40 the vehicle would accomplish its mission and land on the KSC Shuttle Landing Facility (SLF). The vehicle would be towed to a suitable location North of the SLF over a new taxiway of approximately 2,500 ft in length. The vehicle would be placed on its rail transporter, raised to a vertical position and be transported over the existing railways to the SMARF for processing.

VentureStar operations using the SMARF and SLC-40 would be impacted by and impact to some extent Lockheed Martin Evolved Expendable Launch Vehicle (EELV) operations at SLC-41. The SMARF and SLC-40 would have to be evacuated during launches from SLC-41. The EELV Vertical Integration Facilities (VIFs) and SLC-41 would have to be evacuated during SLC-40 launches. However, since both the LMA EELV and VentureStar are on the pad only on launch day, so evacuations would be limited to that period. From the safety standpoint there should be no problem with having loaded vehicles on both pads, such as for test purposes. Should range turn around times allow, there should be no safety problem with launched from one pad while the other pad is occupied with a vehicle.

Launch control for RLV operations at SLC-40 could be based at the MIS facility at the South end of the Titan IV ITL area, possibly in the Vehicle Integration Building, in the current Titan IV Launch Operations Control Facility, or at a new dedicated facility.

This option offers LMA possible synergies for support of EELV and RLV operations. Since new construction is not required, line-of-sight problems for instrumentation should be minimal. Since use of non-disturbed land is small, environmental impact should also be minor.

Option 3A: Option 3 plus use of LC-39 A or B for the second pad

This option would have all of the features of the basic Option 3, but for the second launch pad, LC-39A or LC-39B would be converted for VentureStar use. A suitable taxiway approximately 1800 ft in length would be constructed from LC-39A or LC-39B to the railroad track on the East side of the pads. The vehicle would be taken over the railway on its transporter to LC-39. Once there, it would be lowered to horizontal position, moved to the pad, raised to the vertical position again, fueled, and

launched. Alternatively, a rail spur could take the vehicle to LC-39A/B to enable a near-duplication of the LC-40 site. If true dual, simultaneous processing capability is required, another processing facility could be built on LC-39A/B.

Assessment

All three of the basic options presented here offer advantages and disadvantages. All three appear to be acceptable from the standpoint of safety requirements and range/base support considerations.

Option 1 enables the most baseline-like approach. It does require a substantial amount of construction of new facilities. Most significantly, it probably will subject the VentureStar program to the largest amount of impact due to other program activities; the actual impact to program activities still must be assessed.

Option 2 enables a significant reduction in VentureStar program impacts due to other launch program activities. The relatively remote location of the launch pad reduces the degree to which VentureStar operations will be impacted by other launch activities. It also enables use of the SLF runway, which is more desirable than the Skid Strip due to its concrete construction and greater length. This option also preserves the Baseline Approach. However, it requires the largest amount of construction and has the largest environmental impact.

Option 3 requires significant changes in the VentureStar processing approach. If vertical processing is possible, this option would require only a small amount of construction. Use of the SLF would be enabled, but without the cost of extensive taxiways. Environmental impacts would be quite small. As a result, this would be the lowest cost option. Compared to Option 2, there would be somewhat more impact to and from the VentureStar program due to other launch programs' activities.

All three of the options enable the use of a Space Shuttle pad to augment the initial launch pad once VentureStar operations mature. It does not appear to be feasible to utilize either LC-39A or LC-39B as the initial VentureStar pad due to the Space Shuttle schedule. Once VentureStar has assumed the majority of the Space Shuttle mission set, it should be possible to utilize one pad at LC-39 for new programs. With this as a caveat, NASA should be able to approve such future use of the Space Shuttle pads.

Conclusion

The combined capabilities of the KSC and CCAS complexes offers a unique and extraordinary variety of options to support VentureStar operations. These are not to be equaled any place in the world. A number of actions need to be taken to enable the options presented in this paper to be further evaluated.

NASA should establish and state the conditions for which the LC-39 Space Shuttle pads could be made available for other programs' use.

Lockheed Martin should consider alternatives to the baseline processing approach to enable unique resources to be utilized for the program so to lower start-up costs.

The Air Force and NASA/KSC should work with the State of Florida to develop rough order costs for the options described.

Disclaimer

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